THE MECHANICAL PROPERTIES OF CONCRETE CONTAINING PALM OIL CLINKER AS FINE AGGREGATE REPLACEMENT

MOHAMMED YAHYA AL-AMRI

B. ENG(HONS.) CIVIL ENGINEERING

UNIVERSITI MALAYSIA PAHANG

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MOHAMMED YAHYA AL-AMRI

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SUPERVISOR'S DECLARATION

"I hereby declare that I have checked this project report and, in my opinion this thesis is adequate in terms of scope and quality for the award of the degree of Bachelor of Civil Engineering (Hons)."

Signature :

Name of Supervisor : ASSOC. PROF. DR. KHAIRUNISA BINTI MUTHUSAMY

Date : 9th JUNE 2018

STUDENT'S DECLARATION

"I hereby declare that the work on this thesis is my own except for quotation and summaries, which have been duly, acknowledge in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree."

Signature	:	
Name	:	MOHAMMED YAHYA AL-AMRI
ID Number	:	AA13300
Date	:	9^{th} JUNE 2018

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ABSTRACT

The increasing sand mining activity to due to growth of construction industry in Malaysia, demand toward construction material. and the escalation of palm oil clinker (POC) disposal from Malaysian palm oil industry have caused negative impact to the environment quality. Uncontrolled river sand mining activity can cause ecological imbalance such as destruction of flora and fauna, river bank erosion and water pollution. The dumping of POC in growing quantity throughout the years worsen the environmental pollution, consumes larger disposal area and increases the cost spent by the palm oil mill in managing the waste. The main aim of this research is to study the mechanical performance of concrete containing palm oil clinker as partial sand replacement. The objectives of this study are to investigate the effect of palm oil clinker as partial sand replacement on workability, compressive, flexural strength and water absorption of concrete. Two mixes were prepared in this research which are control mix and modified mix. The slump test decreases as the percentage of palm oil clinker content replaced becomes higher. Reduction of palm oil clinker in the concrete mix workability is probably due to the higher rate of water absorption of this fine aggregate which possess higher porosity as compared to natural sand. The presence of POC as partial replacement of sand in concrete would reduce the compressive strength of concrete. Concrete containing 20% of POC as partial sand replacement recorded that it achieved about 90% of the strength of the control concrete. It is the highest among the other replacement percentage of POC. The presence of POC as partial replacement of sand in concrete would affect the flexural strength. However, the sample containing 20% of POC had the highest flexural strength compared to 10%, 30% and 40% of POC replacements. The concrete containing 20% of POC as partial sand replacement have 87% of the flexural strength of the control concrete. POC as partial sand replacement in concrete production would increase the water absorption value of concrete. The percentage of water absorption of the concrete increase with the increment in the amount of POC in concrete. Conclusively, 20% of POC is the optimum amount to be compared among other replacement to be used as partial sand replacement to produce concrete.

ABSTRAK

Peningkatan aktiviti perlombongan pasir disebabkan oleh pertumbuhan industri pembinaan di Malaysia, permintaan terhadap bahan binaan. dan peningkatan klinker minyak kelapa sawit (POC) dari industri minyak sawit Malaysia telah menyebabkan kesan negatif kepada kualiti alam sekitar. Aktiviti perlombongan pasir sungai yang tidak terkawal dapat menyebabkan ketidakseimbangan ekologi seperti pemusnahan flora dan fauna, hakisan tebing sungai dan pencemaran air. Pembuangan POC dalam kuantiti yang semakin meningkat sepanjang tahun memburukkan pencemaran alam sekitar, menggunakan kawasan pelupusan yang lebih besar dan meningkatkan kos yang dibelanjakan oleh kilang minyak kelapa sawit dalam menguruskan sisa buangan. Tujuan utama kajian ini adalah untuk mengkaji prestasi mekanikal konkrit yang mengandungi klinker minyak sawit sebagai pengganti pasir separa. Objektif kajian ini adalah untuk mengkaji kesan klinker kelapa sawit sebagai pengganti pasir separa pada kebolehkerjaan, kekuatan mampatan, lenturan dan penyerapan air konkrit. Dua campuran telah disediakan dalam kajian ini yang merupakan campuran kawalan dan campuran diubah suai. Ujian kemerosotan menurun apabila peratusan kandungan klinker minyak sawit diganti menjadi lebih tinggi. Pengurangan klinker minyak sawit dalam kebolehkerjaan campuran konkrit mungkin disebabkan kadar penyerapan air yang lebih tinggi dalam agregat halus ini yang mempunyai keliangan yang lebih tinggi berbanding dengan pasir semulajadi. Kehadiran POC sebagai penggantian separa pasir dalam konkrit akan mengurangkan kekuatan mampatan konkrit. Konkrit yang mengandungi 20% POC sebagai pengganti pasir separa mencatat bahawa ia mencapai kira-kira 90% kekuatan konkrit kawalan. Ia adalah yang tertinggi di kalangan peratusan pengganti lain POC. Kehadiran POC sebagai penggantian separa pasir dalam konkrit akan menjejaskan kekuatan lenturan. Walau bagaimanapun, sampel yang mengandungi 20% POC mempunyai kekuatan lenturan tertinggi berbanding dengan 10%, 30% dan 40% penggantian POC. Konkrit yang mengandungi 20% POC sebagai pengganti pasir separa mempunyai 87% kekuatan lenturan konkrit kawalan. POC sebagai penggantian pasir separa dalam pengeluaran konkrit akan meningkatkan nilai penyerapan air konkrit. Peratusan penyerapan air peningkatan konkrit dengan kenaikan jumlah POC dalam konkrit. Secara konsisten, 20% POC adalah jumlah yang optimum untuk dibandingkan dengan penggantian lain untuk digunakan sebagai pengganti pasir separa untuk menghasilkan konkrit.

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LIST OF SYMBOLS

%	Percent
mm	Millimetre
mm^2	Millimetre square
m^3	Cubic metre
µm	Micro metre
g	Gram
kg	Kilogram
kg/m^3	Kilogram per cubic metre
MPa	Mega Pascal
kN	Kilo newton
°C	Degree Celsius
°	Degree
kN/sec	Kilo newton per second
f_c	Compressive strength of concrete specimen
P	Maximum load carried by the specimen during testing
A	Area
R	Modulus of Rupture
l	Distance between the support
b	Net width
d	Depth

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

Green construction material takes important role in sustainable development. Brundtland Report (1987) about sustainability has driven the global concept of sustainability as well as the sustainability of infrastructure. Since concrete has become the most popular construction material in the world, sustainable concrete will determine the sustainability of infrastructure. Several efforts have been done to achieve the sustainable concrete. Those efforts make the concrete technology innovation ‘green’, less energy, and less carbon emission (Susilorini et al., 2014).

Concrete is one of the most important materials in building construction and other infrastructure works. About 2.7 billion m^3 of concrete was generated in 2002 worldwide, which is more than 0.4 m^3 of concrete generated per person once a year (Naik, 2008). It is anticipated that the need for concrete will increase further to almost 7.5 billion m^3 (about 18 billion tons) a year by 2050 (Monteiro, 2015). Such an enormous utilization of concrete calls for higher use of natural aggregates and cement, thus taking toll on the environment. At least three-quarters of the total volume of concrete consists of coarse and fine aggregates (Rafieizonooz, 2016).

At the same time in Malaysia, the government, professional bodies and private companies are beginning to take heed in the necessity to reduce this environmental problem. Construction industry must inevitably change its historic methods of operating with little regard for environmental impacts to a new mode that makes environmental concerns a on the concern previously, centerpiece of its efforts. Environment is relatively a small part of most of construction development. However, with the growing awareness on non-of depletion to protection due environmental the renewable resources, global warming and extremity of destruction to ecology and biodiversity impact, this issue have construction practitioners the by gain wider attention worldwide (Nazirah Zainul Abidin, 2010).

It is known that concrete technology innovations have been implemented in construction industry. However, those innovations are still limited to meet criteria of green construction material. Therefore, we need more breakthroughs of concrete technology to fulfil the worldwide needs of green construction material.

1.2 PROBLEM STATEMENT

The problem of waste accumulation exists worldwide, specifically in the densely populated areas. Most of these materials are left as stockpiles, landfill material or illegally dumped in selected areas. Large quantities of this waste cannot be eliminated. However, the environmental impact can be reduced by making more sustainable use of this waste. This is known as the ’’Waste Hierarchy’’ as shown in (figure 1.1). Its aim is to reduce, reuse, or recycle waste, the latter being the preferred option of waste disposal (Batayneh, et al., 2007).

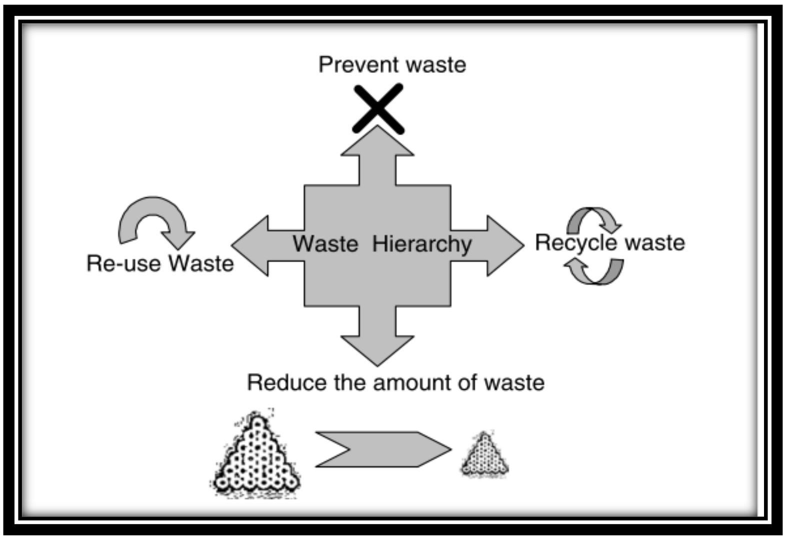

Figure 1.1: Waste Hierarchy

A further serious problem is that the productive chain of civil engineering uses huge amounts of raw materials. In recent years, rapid development has led to an increased demand for river sand, which is largely used as a fine aggregate for construction. The extraction of sand from river bed and river bank may cause adverse effects on the environment, like river bank erosion, river bed degradation, and deterioration of river water quality (Santos, et al., 2013). Therefore, utilizing waste materials as partial sand replacement would save river sand and also reduce wastes at landfills.

Malaysia, being one of the largest producer and manufacturer of palm oil products, generates large amount of palm oil by-products, and Palm Oil Clinker is one of it. If this palm oil clinker is put into good use, in this case as a main material in concrete mix production, then it will largely reduce the cost of concrete production. At the same time, it will also reduce the amount of waste generated by the palm oil industry thus achieving a global aim of sustainable development. Not only it reduces the waste, it also preserves the nature by eliminating the need to harvest natural aggregates from natural sources (Ahmad & Mohd, 2007).

1.3 OBJECTIVE OF STUDY

The study was conducted to achieve the following objectives:

i. To investigate the effect of palm oil clinker as partial fine aggregate replacement on the workability and compressive strength of concrete.
ii. To investigate the effect of palm oil clinker as partial fine aggregate replacement on the flexural strength of concrete.
iii. To investigate the effect of palm oil clinker as partial fine aggregate replacement on water absorption of concrete.

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